Minutes of the 156th Energy Calibration Meeting held on 12 June 1998

1 News

It has been discovered that the NMR's were logged incorrectly up until this week. This year's table in the database only allowed a precision of 1 Gauss, so the values stored so far are essentially useless. The NMR's are now being logged correctly, and work is in progress to recover the data up to now from the private logging.

The final energy files for the 1997 data have been released by Guy Wilkinson. No problems have been reported.

2 ISR modelling uncertainty for radiative returns

Stanislaw Jadach discussed whether the uncertainty from initial state radiation is less than 10 MeV on $E_{\rm beam}$.

For two fermion production at LEP2, there are peaks in the cross section as a function of sprime, for full energy events, in the region of the Z mass, and at low energy from two photon events. The relative normalisation of these peaks is not important, but the position of the Z peak relative is critical to measure the beam energy.

Staszek showed the distribution of true sprime in the region of the Z peak from the Monte Carlo, but via the variable $v = 1 - s'/s$. He then compared this with v reconstructed from the angles of the muons. There seemed to be some problem with the normalisation of the Z peak in this stage, since about half the events were lost. The peak also got wider.

In order to investigate the effect of changing the beam energy, a trick to save regenerating every MC event is to change the Z mass. This simulates a change in beam energy of twice the change in the Z mass.

The effect of switching off various contributions to the cross section can be checked in a similar way. The ISR $O(\alpha^2 L^2)$ effect is below 10 MeV. (The change in cross section is nearly constant with v, so this doesn't affect the measurement of $E_{\rm beam}$.) Switching on/off the $O(\alpha^3 L^3)$ has an even smaller effect. The small change from the $O(\alpha^2 L^2)$ on/off can be understood from the cancellation of the contribution to the cross section and the shift in the beam energy. There is also a Γ^2/M^2 suppression.

In summary, the pure ISR effects are under control at the $<$ 10MeV level, although the $\alpha^2 L$ term is still missing. For initial-final state interference, the calculation is in progress, and the effect again has Γ/M suppression. For final state radiation, again the effects are under control.

The above refers to mu pair final states. There is some hope that hadronisation effects may cancel between the γZ and WW events being studied.

3 Experimental progress with beam energy from radiative returns

Jim Libby showed an update of the delphi $\mu\mu\gamma$ analysis by himself and Geoff Morton. The selection to find well measured events is about 85% efficient. The fit has been improved by confoluting a radiator function with the Breit Wigner describing the Z peak. This reduced the bias of the measurement from about 500 MeV to 170 MeV (KoralZ) or 93 MeV (Dymu3, which has a much more naive treatment of ISR). This bias is the offset between the true beam energy and the inferred beam energy from the fit to the s' distribution. It is independent of true beam energy within the statistics of the MC samples.

Fitting to fully simulated data, the effective Z width increased further. The uncertainty for 2fb-1 (i.e. four delphi equivalents with 500pb-1 each) is about 37 MeV. For a sample of 50pb-1 (i.e. one delphi's worth of 1997 data) the expected error is about 220 MeV.

From the real data, the beam energy is measured with a precision of about 270 MeV. Fitting many MC samples of 50pb-1 to test the spread of expected errors, the mean error was about 240 MeV with an rms of 34 MeV, so the fitted error from real data is unlucky but quite reasonable. The central value from the fit was 91.592 GeV (after correcting for the bias), which is quite consistent with the average beam energy at delphi of 91.335 GeV.

4 Extrapolation errors

Peter Renton has used the "banana" residuals of NMR averages w.r.t. the energies in the 4-point polarisation fills in 1997 to estimate the systematic uncertainty. He increases the errors in the two parameter fit to a straight line until the χ^2/dof is 1. With these inflated errors, the extrapolated uncertainty at a physics beam energy of 91.5 GeV is 6.9 MeV.

Pete has also revisited the 1998 flux loop data, using only the 11 NMR's that were working for the 1997 4 point polarisation fills. The residuals show a banana of the same sign as the polarisation banana, but with reduced amplitude. The polarisation banana has a maximum deviation of 2 MeV, while the flux loop banana has a maximum amplitude of about 0.5 MeV.

5 Next meeting

The next meeting will be on Friday 19 June at 15:00 in the Pavillon.

Pippa Wells, 15 June 1998